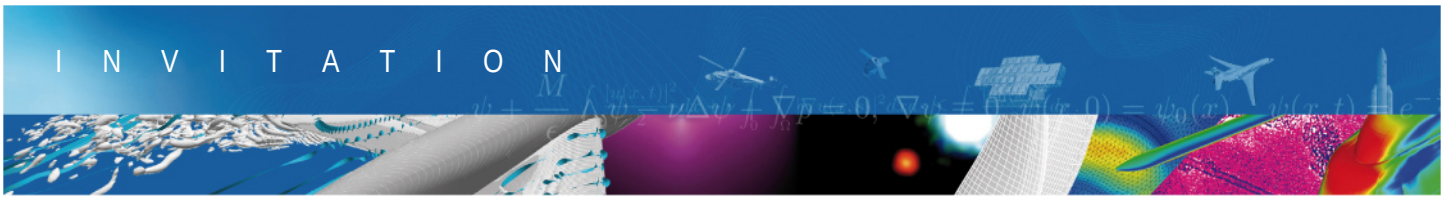

Enhanced probabilistic tools to improve verification and validation of space control systems

Soutenance de thèse – Franca SOMERS

29 novembre 2024 à 10h00

Amphi 1 ISAE-SUPAERO, 10 avenue Edouard Belin, Toulouse

Devant le jury composé de :

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Résumé

Current verification and validation (V&V) activities in aerospace industry mostly rely on time-consuming simulation-based tools. These classical Monte Carlo approaches have been widely used for decades to assess performance of Guidance, Navigation and Control (GNC) algorithms and Attitude and Orbit Control Systems (AOCS) containing multiple uncertain parameters. They are able to quantify the probability of sufficiently frequent phenomena, but they may fail in detecting rare but critical combinations of parameters. As the complexity of modern space systems increases, this limitation plays an ever more important role. In recent years, model-based worst-case analysis methods have reached a good level of maturity. Without the need of simulations, these tools can fully explore the space of all possible combinations of uncertain parameters and provide guaranteed mathematical bounds on robust stability margins and worst-case performance levels. Problematic parameter configurations, identified using these methods, can be used to guide the final Monte Carlo campaigns, thereby drastically shortening the standard V&V process. A limitation of classical model-based worst-case analysis methods is that they assume the uncertain parameters can take any value within a given range with equal probability. The probability of occurrence of a worst-case parameter combination is thus not measured and a control architecture can be rejected based on a very rare and extremely unlikely scenario. This PhD research makes advances in probabilistic μ-analysis to develop new efficient and reliable tools to improve the characterization of rare but nonetheless possible events. This to tighten the aforementioned V&V analysis gap between simulation-based methods and deterministic model-based worst-case approaches.

Mots clés

Verification & Validation, robust stability and performance, probabilistic μ-analysis, branch-and-bound algorithms, probabilistic robust controller synthesis

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